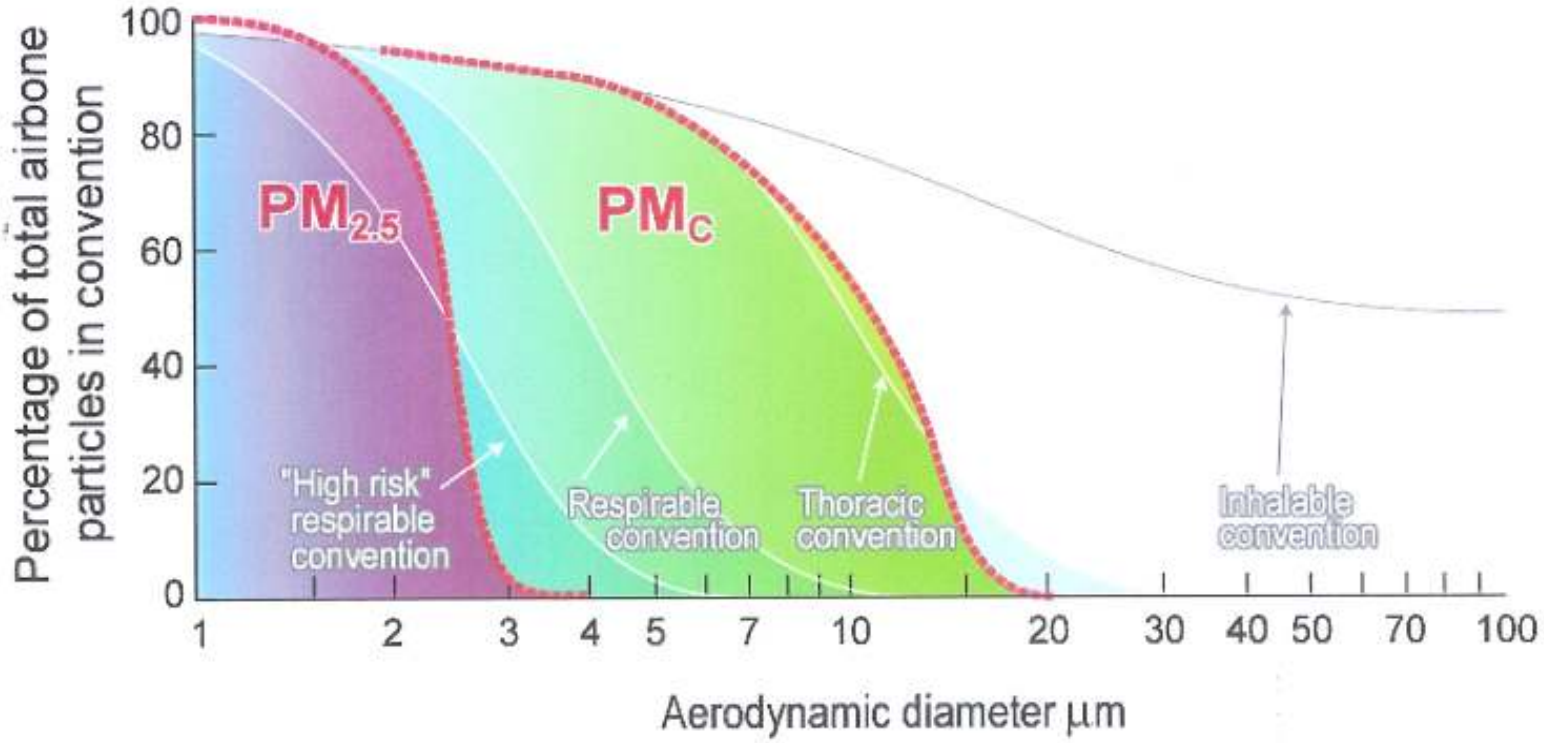
Design & Three Years Field Testing of a Continuous PM 10, PM2.5. PMc & Optical Black Carbon Monitor

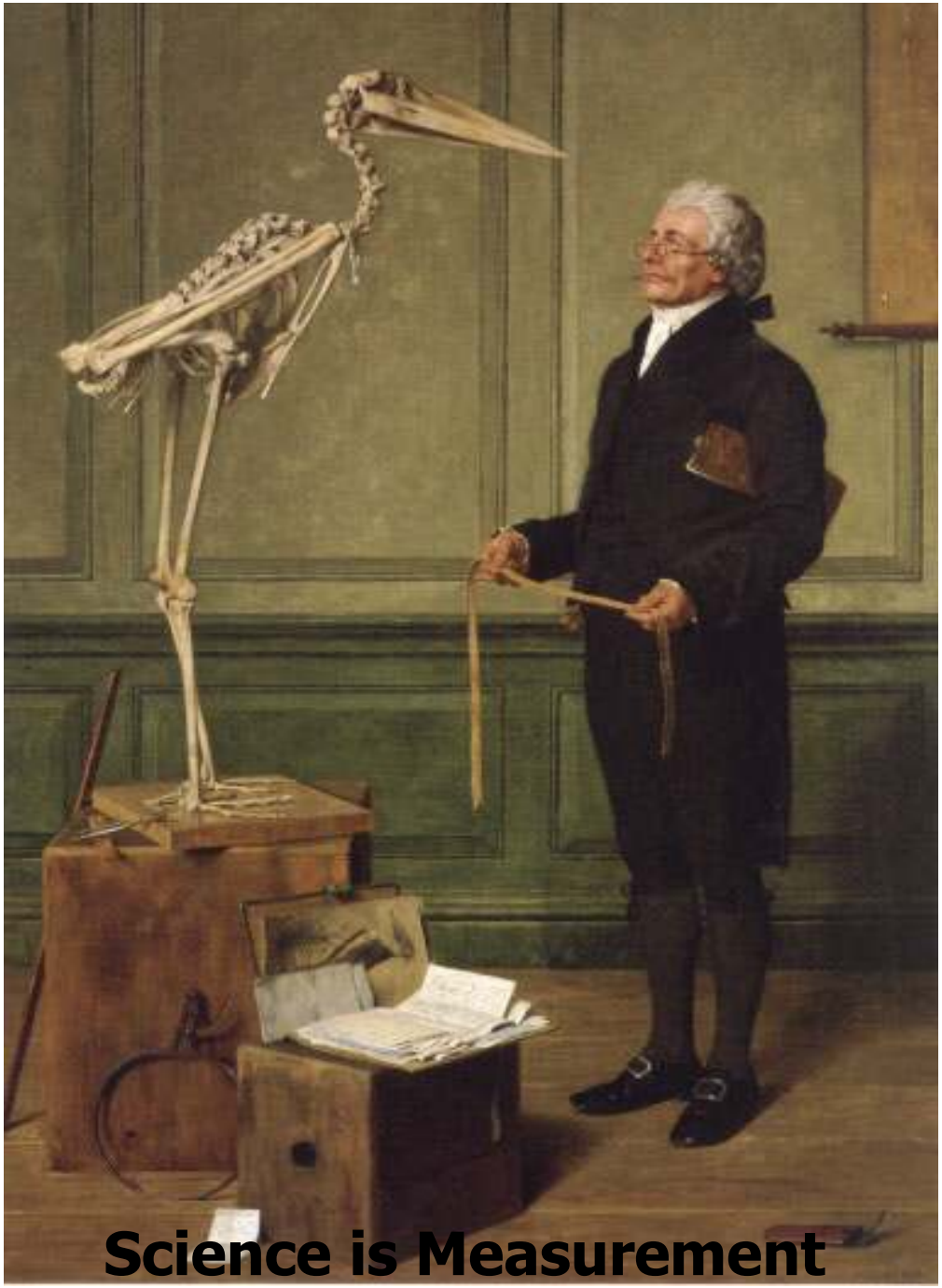
Tisch Environmental

John Tisch



Definitions of PM10 and PM2.5 in relation to the ISO health-related sampling conventions

$$[PM_C] = [PM_{10}] - [PM_{2.5}]$$

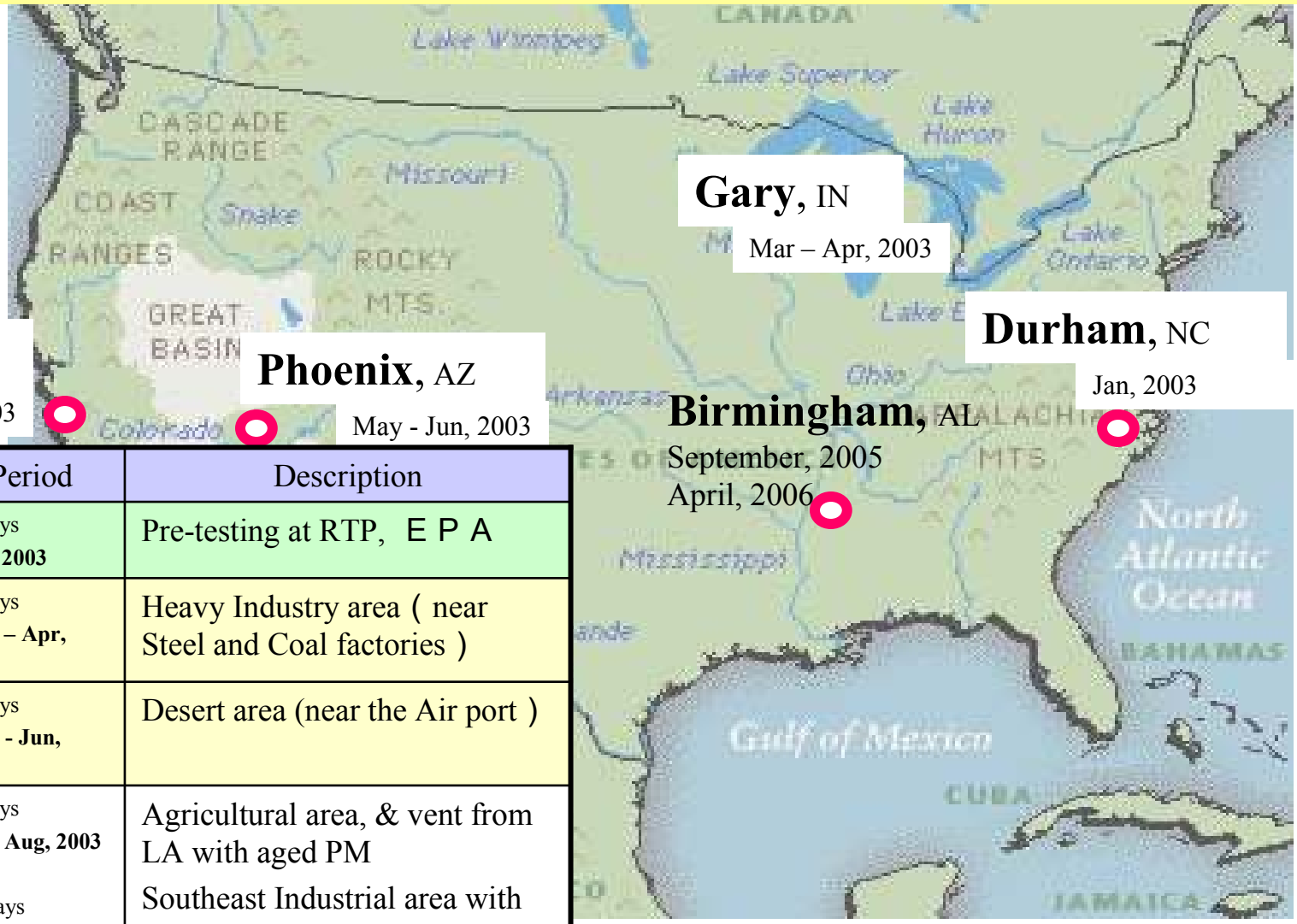


Science is Measurement

(*H.S.Marks, 1879*)

Ambient Particulate Testing is Advancing from Manual Filter Samplers to Continuous Automated Methods Making Multiple Measurements

US-EPA PM Fine & Coarse Air Marathon



Gary, IN
Mar – Apr, 2003

Durham, NC
Jan, 2003

Riverside, CA
Jul - Aug, 2003

Phoenix, AZ
May - Jun, 2003

Birmingham, AL
September, 2005
April, 2006

Site	Period	Description
Durham, NC	10days **Jan, 2003**	Pre-testing at RTP, E P A
Gary, IN	30days **Mar – Apr, 2003**	Heavy Industry area (near Steel and Coal factories)
Phoenix, AZ	30days **May - Jun, 2003**	Desert area (near the Air port)
Riverside, CA	30days **Jul - Aug, 2003**	Agricultural area, & vent from LA with aged PM
Birmingham, AL	30 days **September 2005** 30 days **April 2006**	Southeast Industrial area with high humidity. Urban and industrial mixed site.

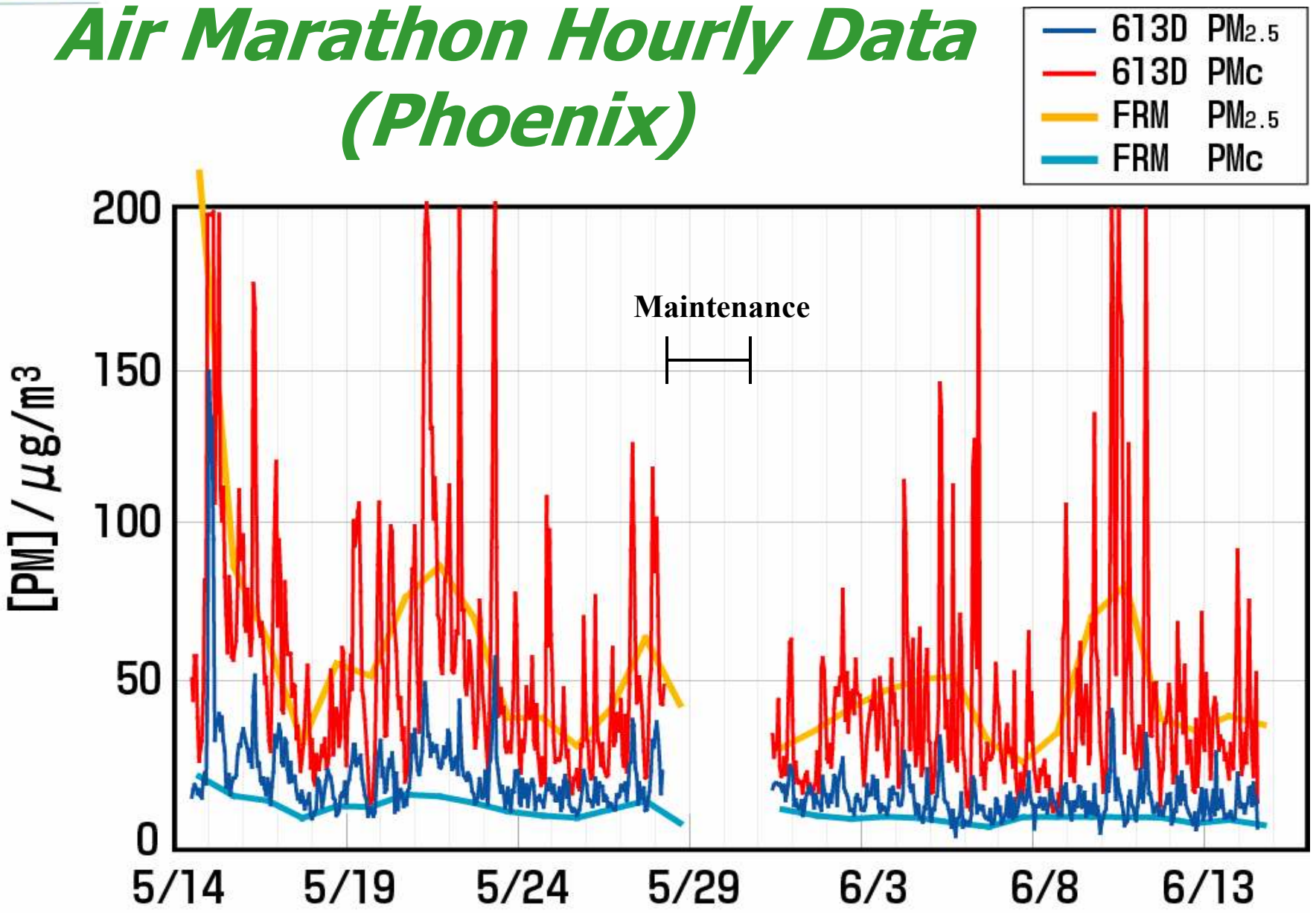
Lessons from Air Marathon Data

Kimoto/Tisch Model SPM613-D Continuous Dichotomous Monitors

Riverside 2003

KIMOTO SPM-613D

Air Marathon Hourly Data (Phoenix)



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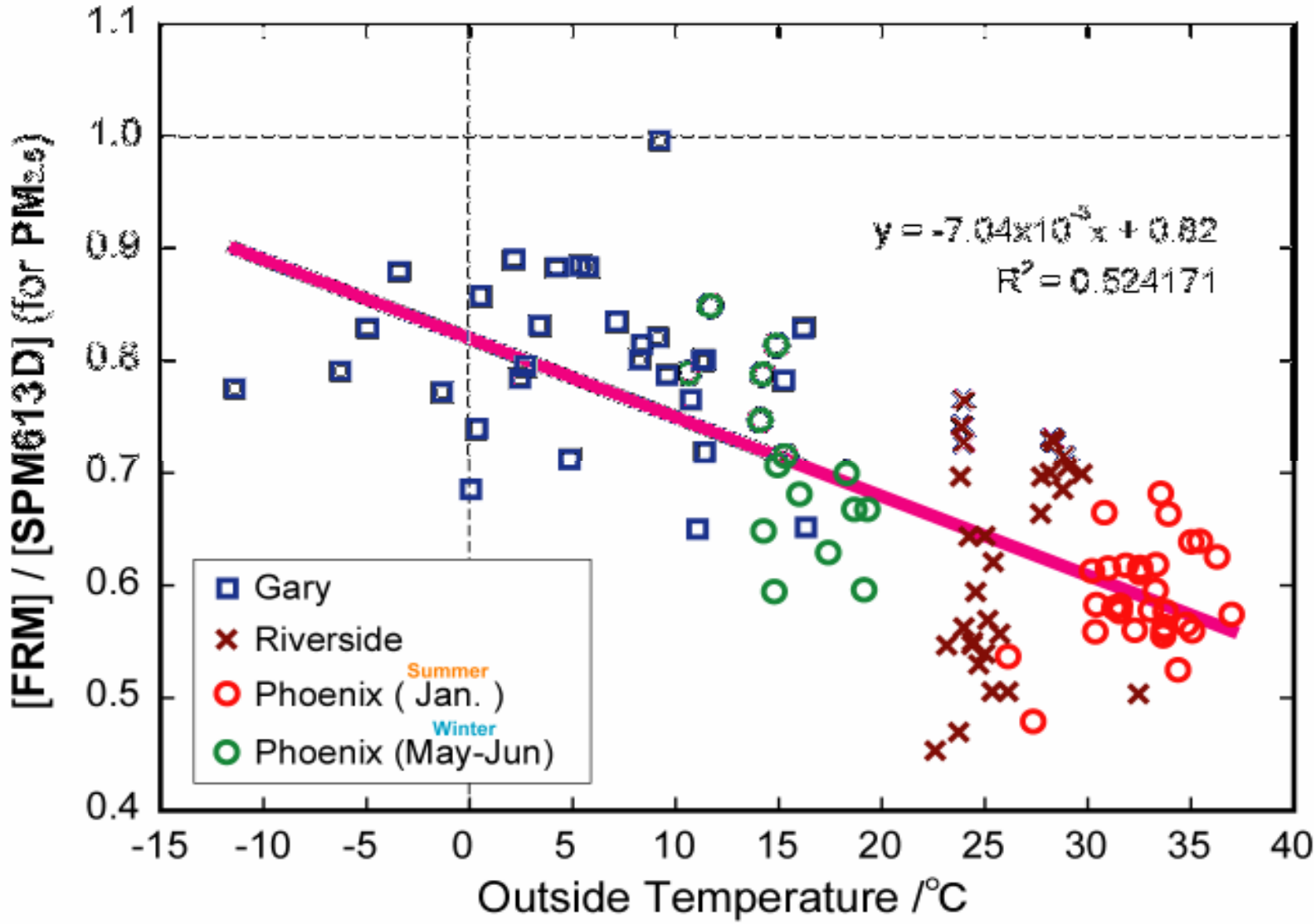
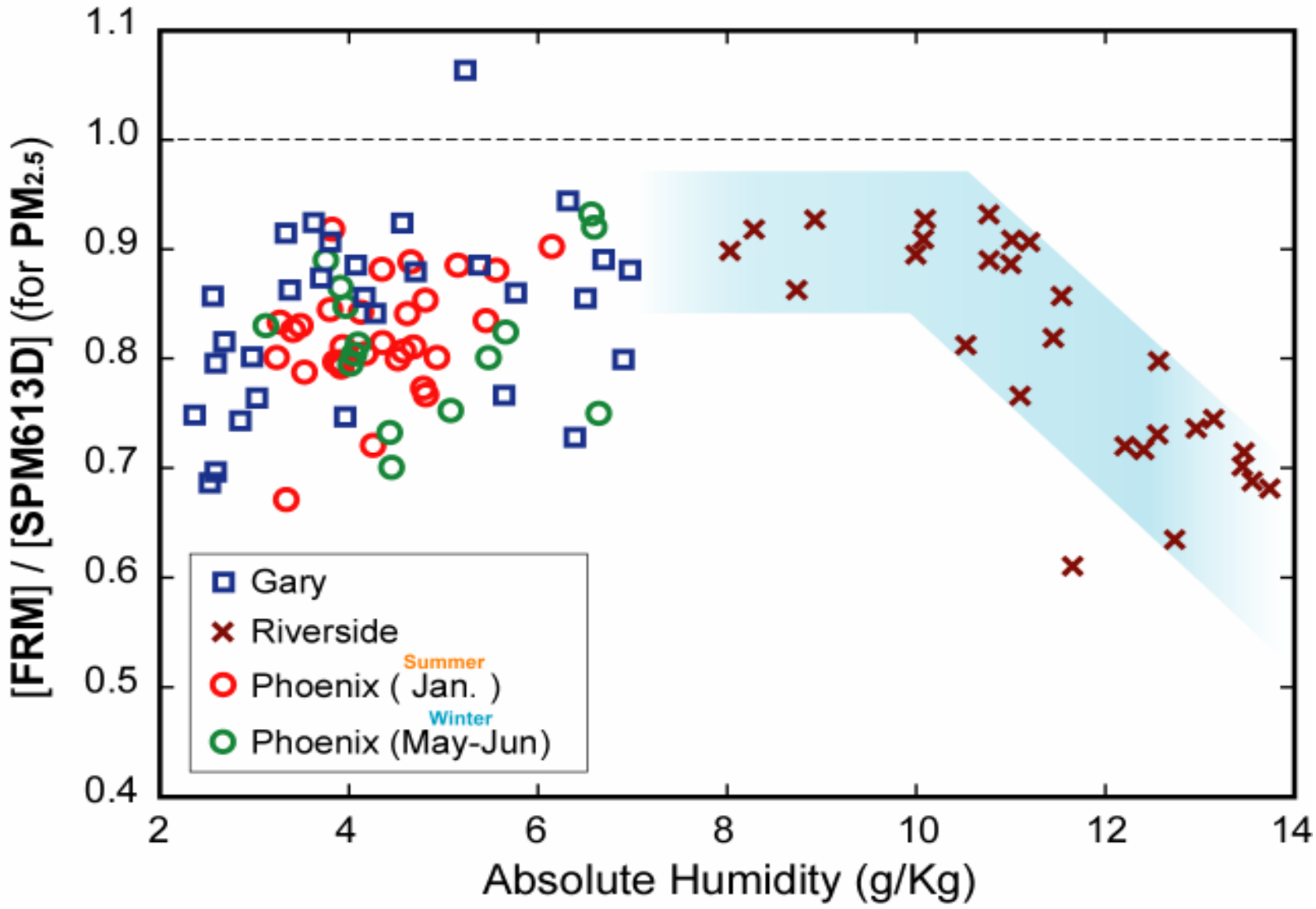
Ambient Temperature Effect
FRM PM2.5 Data



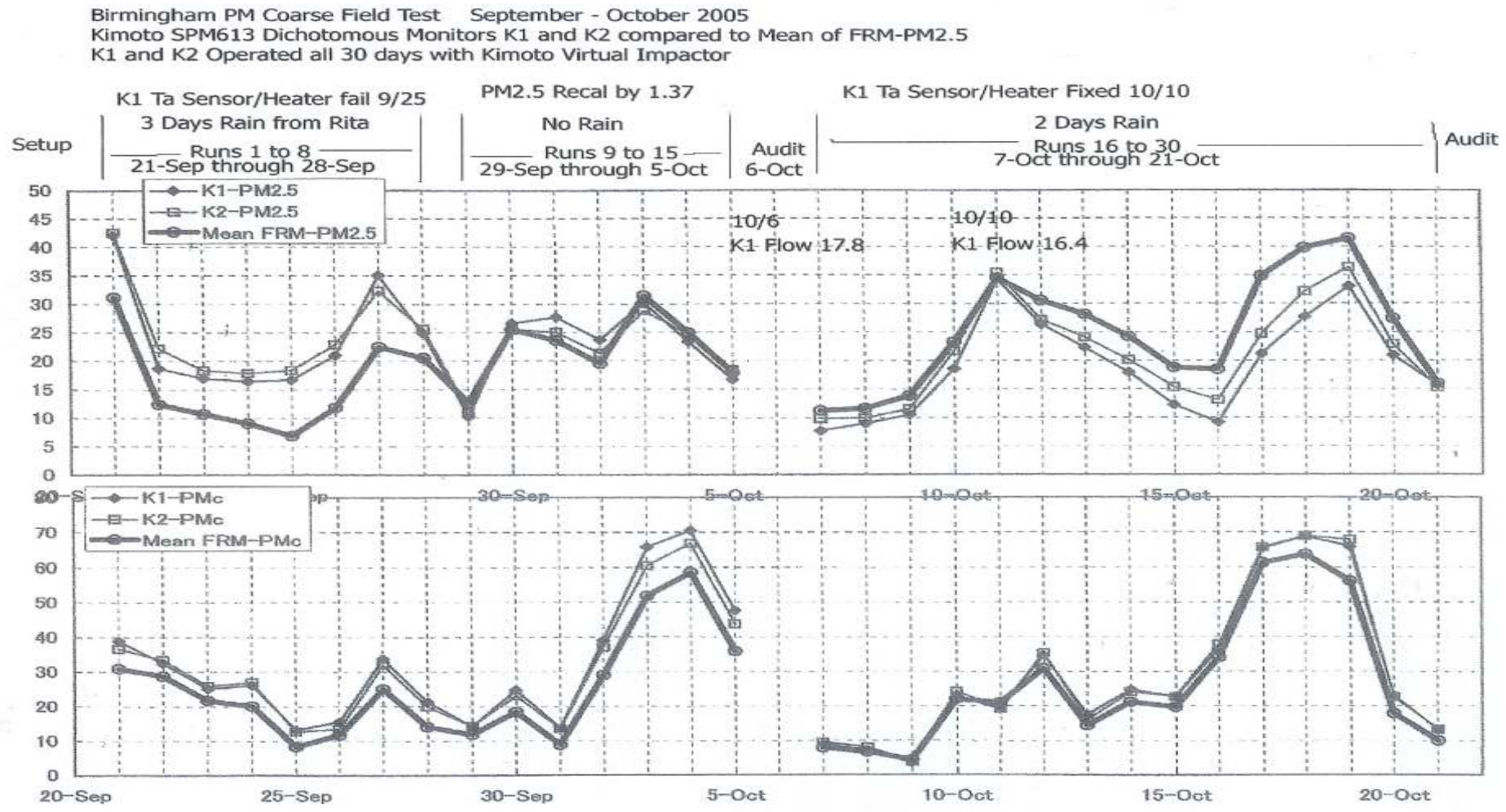
SPM-613D

Ambient Humidity Effect
FRM PM2.5 Data

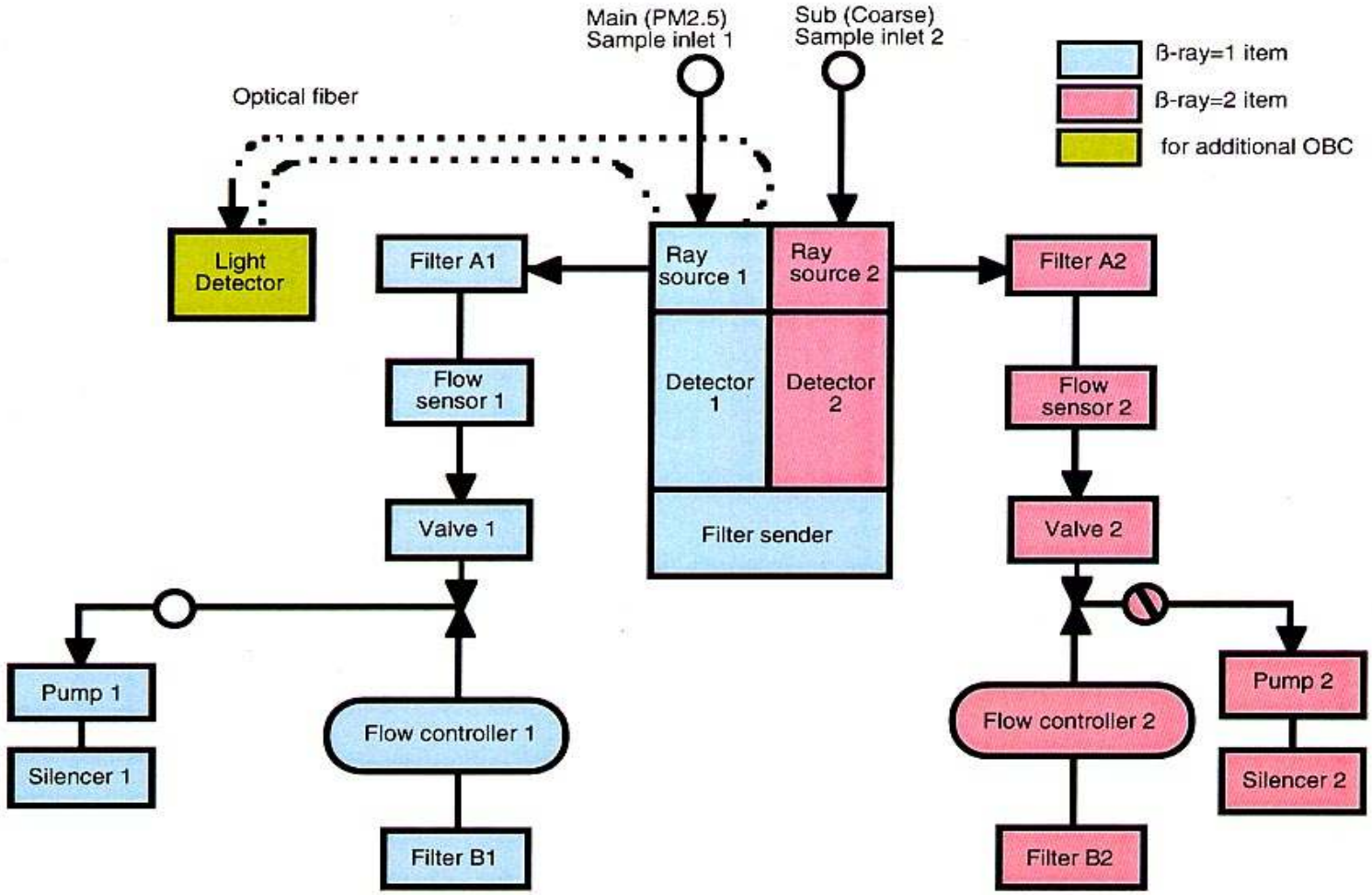


SPM-613D

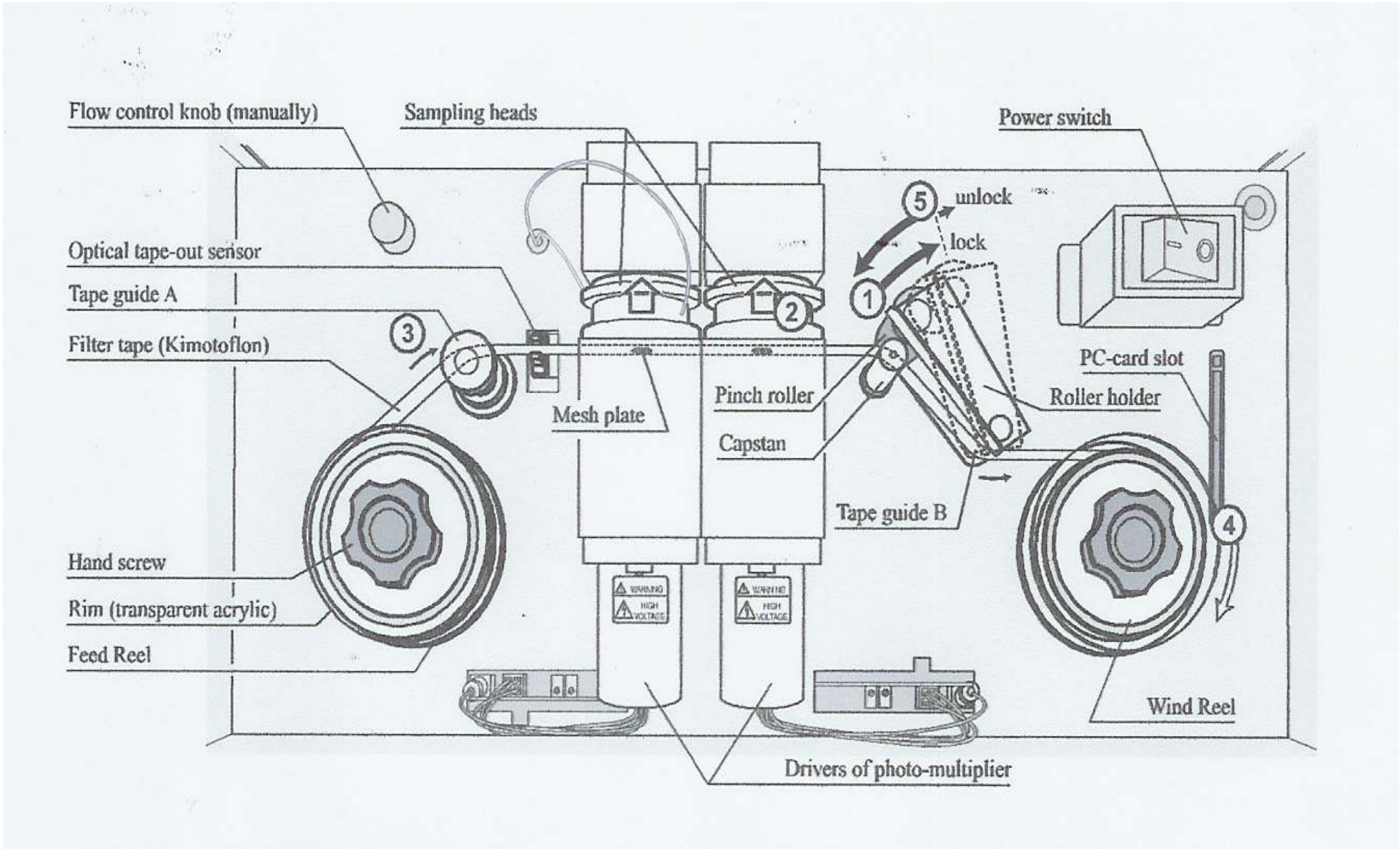
Lessons Learned from North Birmingham Alabama



Schematic of SPM613-D



Automated Dichotomous Monitor

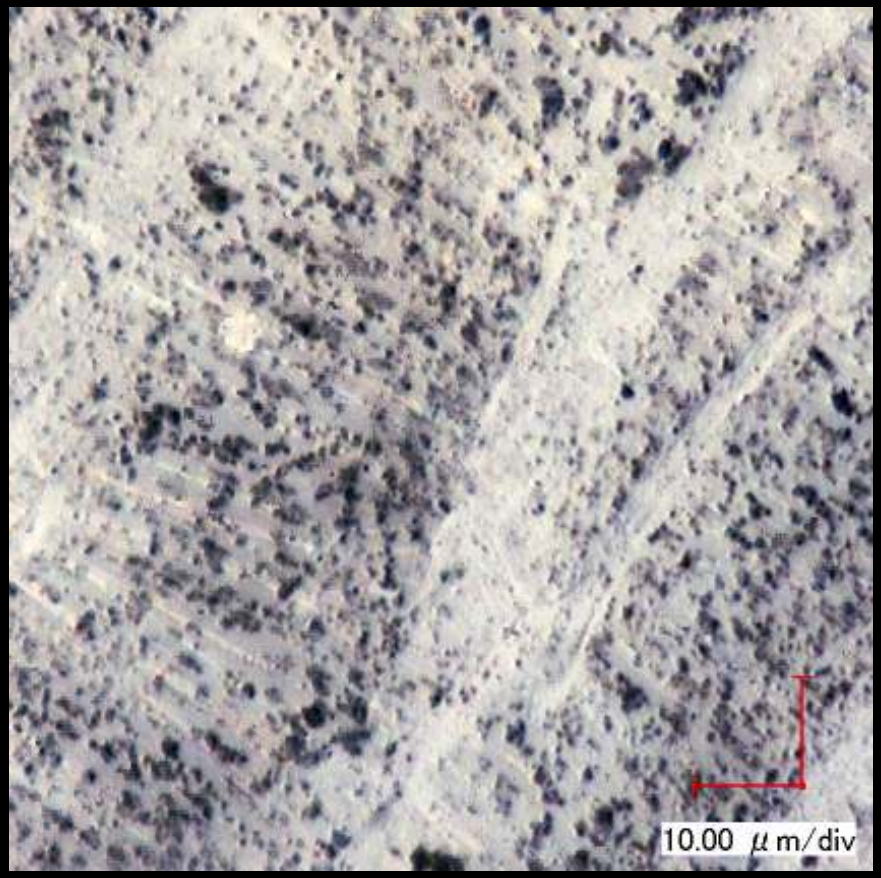


KIMOTO SPM-613D

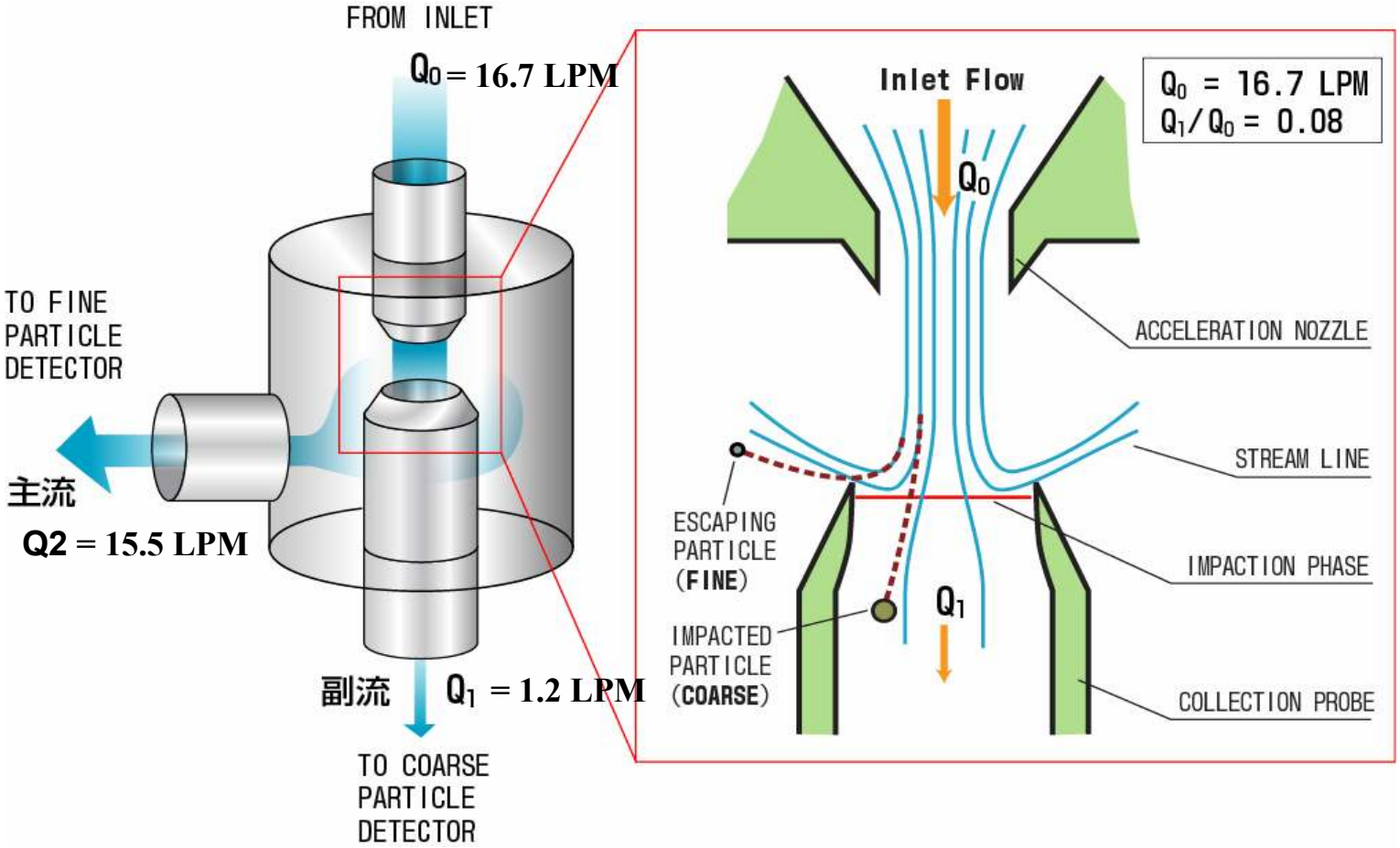
PTFE Filter Surface of PMc and PM2.5

PMc

$PM_{2.5}$



Schematic of Virtual Impactor



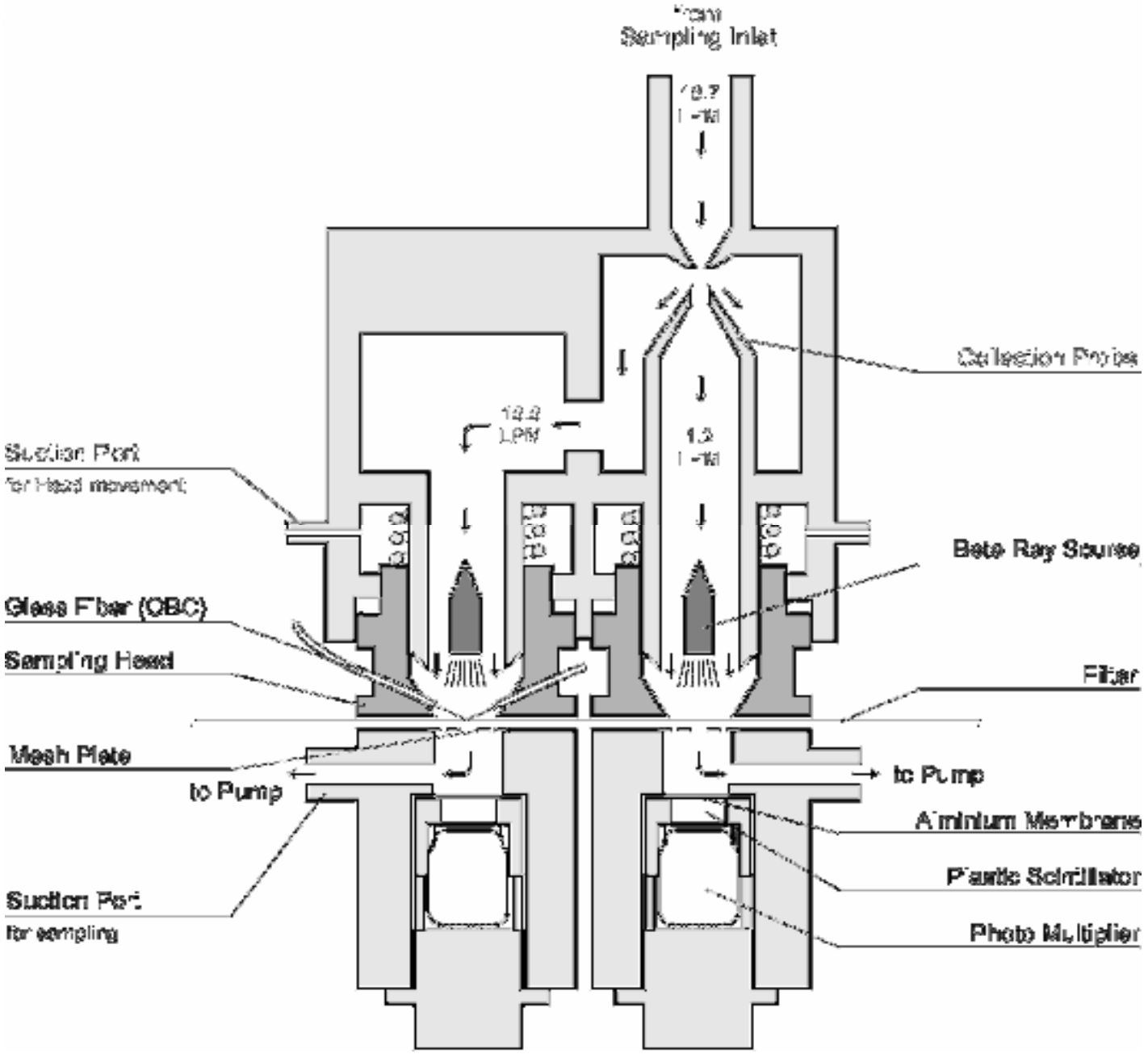
[PM2.5] = [fine] x (16.7 / 15.5)

[PMc] = [coarse] - [fine] x (1.2 / 15.5)

[PM10] = [fine] + [coarse]

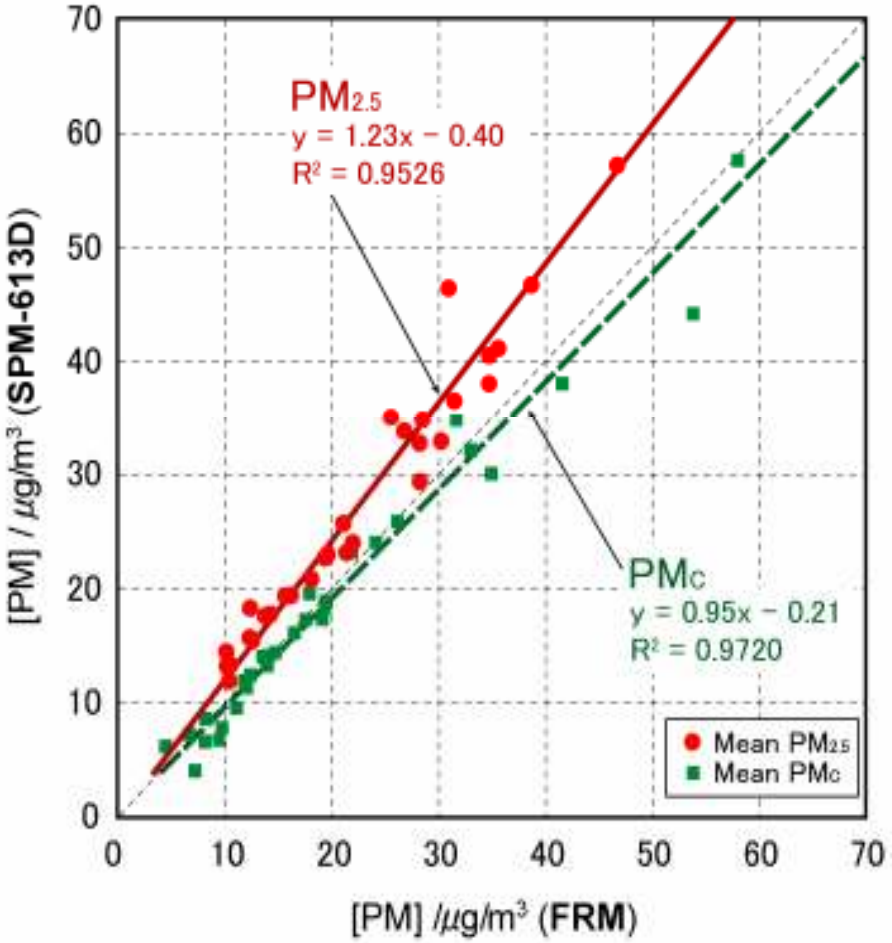
SPM-613D

SPM613-D Detector Configuration

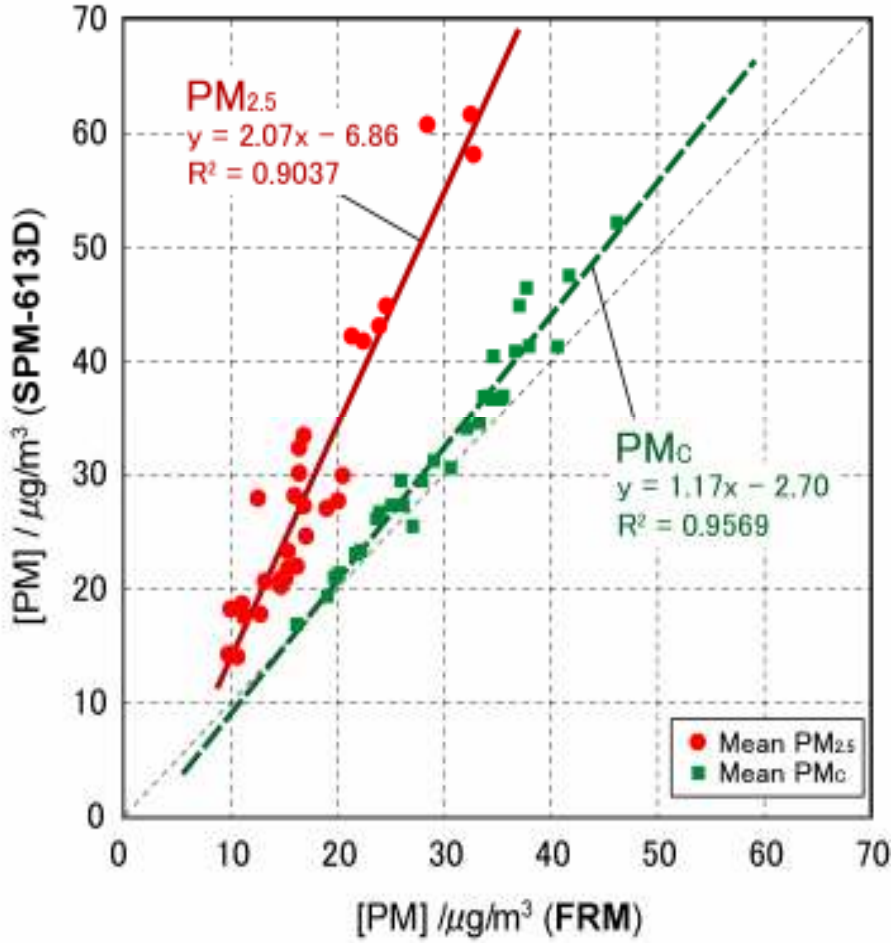


613-D vs. FRM (Gary, Riverside)

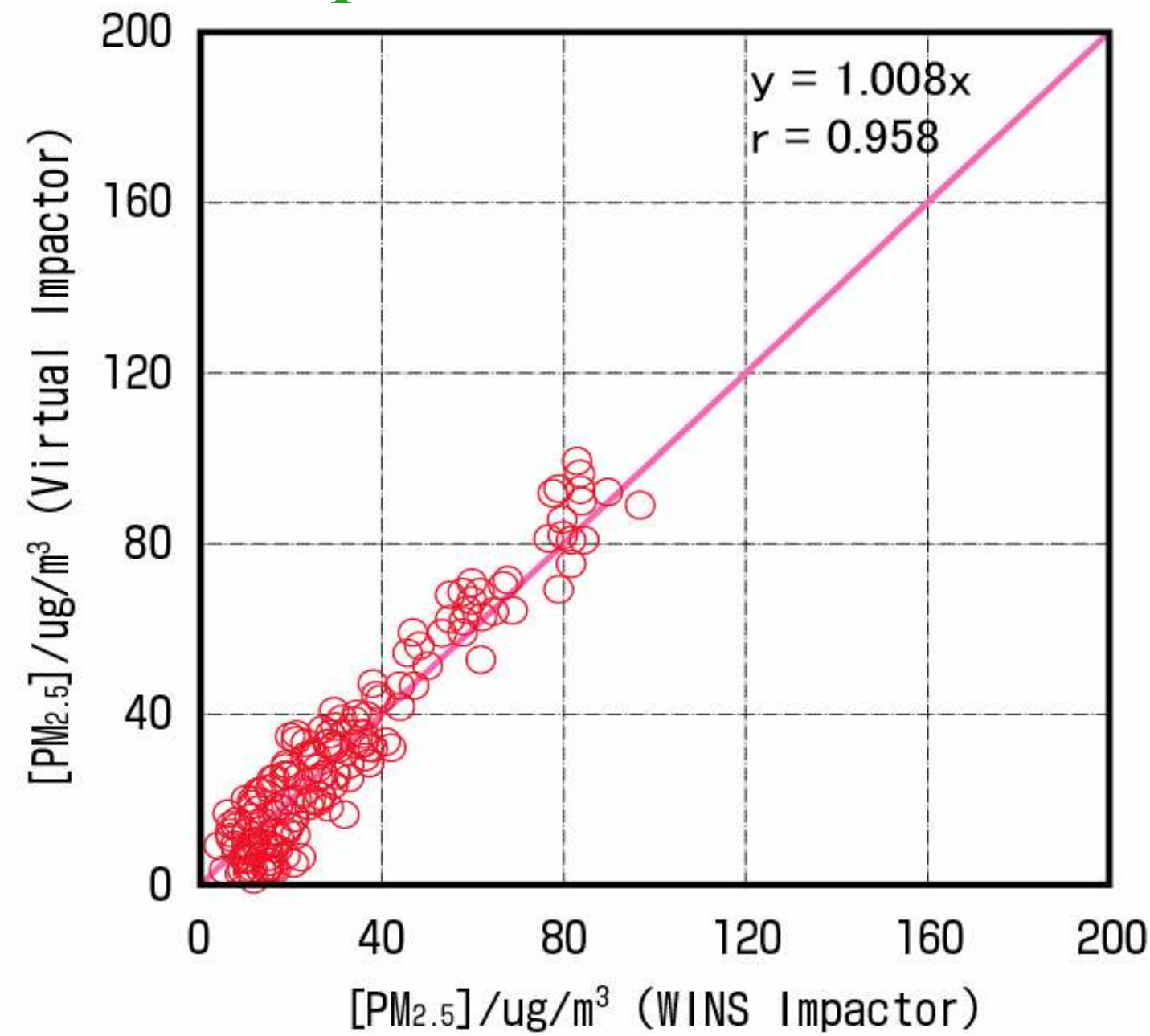
GARY



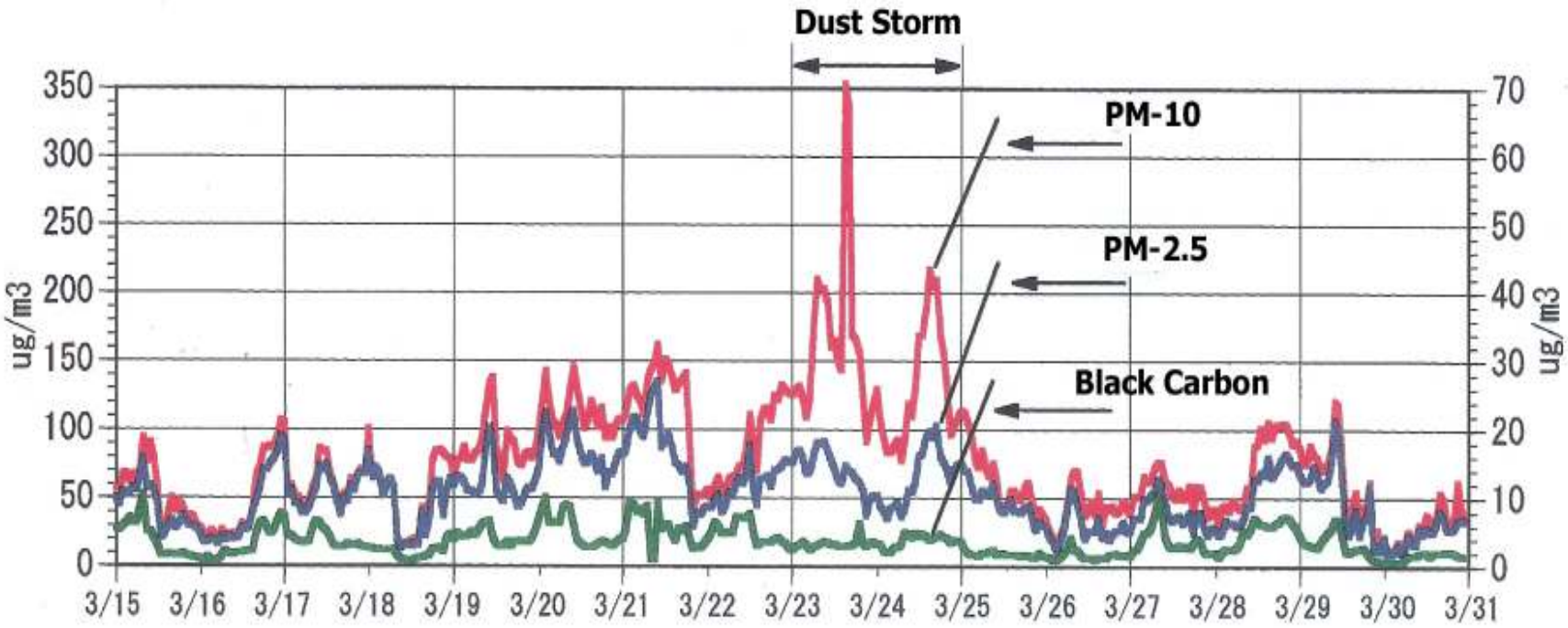
RIVERSIDE



WINS Impactor vs. 613D Virtual Impactor



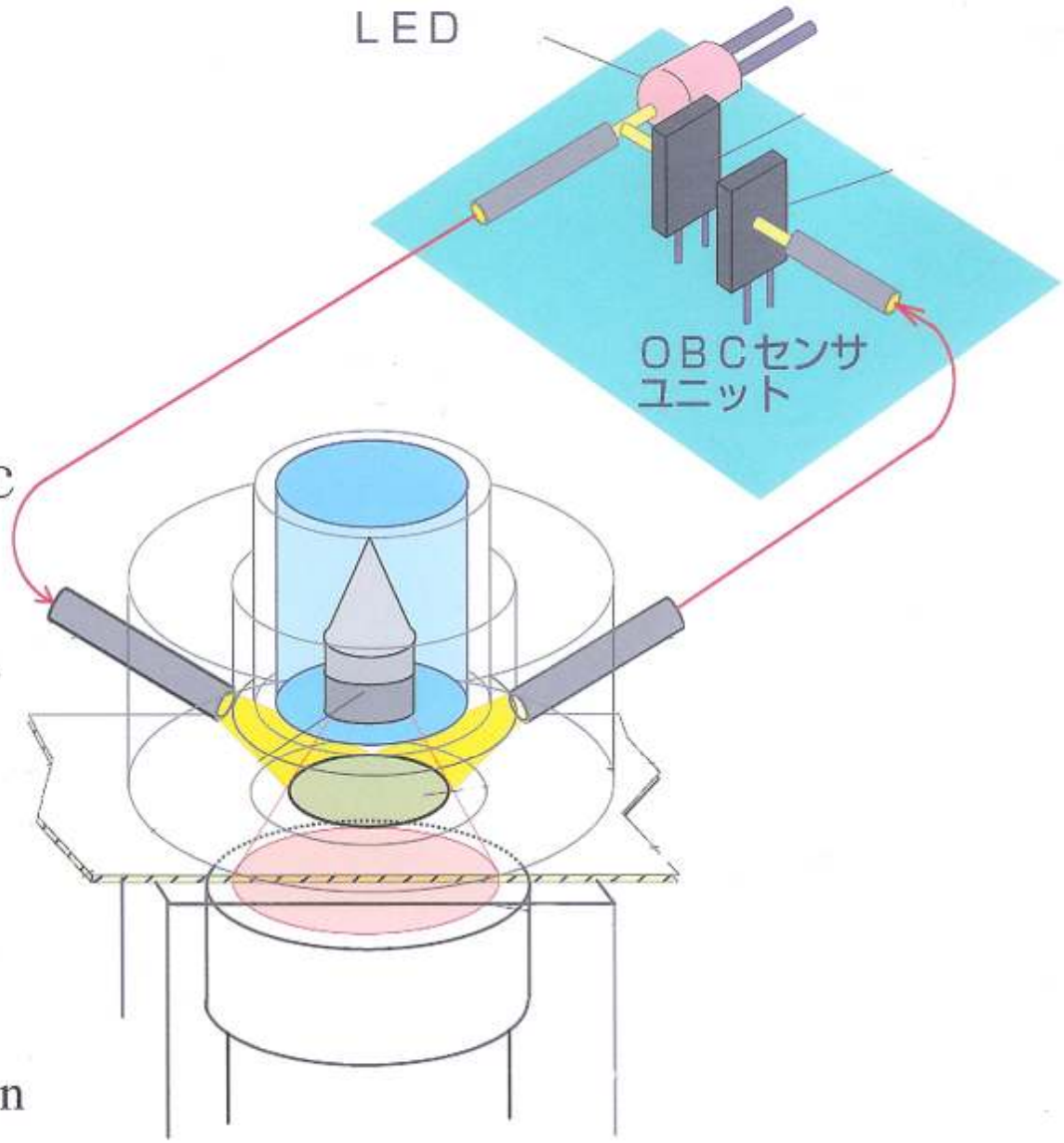
SPM-613D



A Data Plot of Two Weeks Continuous Measurement by the SPM-613D for PM-10, PM-2.5 and OBC.

SPM613-D
Optical Black Carbon Sensor

- Direct Measurement of OBC with Fiber Optics
- LED Source With Fiber Optic Reflectance Sensor



OBC: Optical Black Carbon

SPM-613D

Upgrades from Field Testing

- Added Inlet Heater with Fixed Temperature
- Set Active Sample Time to >59 Minutes
- Changed RS232 to Ethernet & EPA Format
- New Microprocessor & Increased Data Files
- Report Volumetric Flow Rate, Total, Fine, Coarse
- Added External Ambient Temperature & Relative Humidity Sensors
- Changed Inlet Heater to "Active" Control. >35%
- Added Active Flow Rate Display of Total, Fine and Coarse Flows
- Added Certified Mass Foil Calibration Slides
- Reduced PM2.5 Sample Spot size for Higher Sensitivity
- Verified Kimoto Virtual Impactor to Loo & Cork VI
- Increased PTFE Membrane Filter Tape to >45 days
- Added Factory Certified Mass Foil for Optical Black Carbon Calibration

Continuous Improvements

- Simultaneous One Hour Measurement of PM10, PM Fine 2.5 and PM Coarse with Optical Black Carbon of the PM2.5,
- Field Tested and Improved Since 2003
- Patented PTFE Membrane Filter Media Mimics the Same Characteristics as the EPA FRM. The Fluorocarbon Filter Reduces Gas & Moisture Effect to a Minimum and Provides High Sensitivity
- Continuous >59 Minutes/Hour Active Sampling, No Step Function or Switching